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Statement of Work for Solar Dynamics Observatory (SDO) Helioseismic and Magnetic Imager Investigation (HMI): Phase A

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Greenbelt, Maryland 20771

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1. Introduction

This Statement of Work (SOW) details the work to be performed by the Contractor and its team members for the Phase A concept definition portion of the Solar Dynamics Observatory (SDO) mission.

2. Scope Of Work

The Contractor shall provide the necessary resources and skills to perform and manage the tasks defined within this Statement of Work for Phase A and in accordance with the investigation specification entitled Basic Requirements and Objectives of the Helioseismic and Magnetic Imager (HMI) Investigation. The Contractor shall refine and evolve the Contractor's plans, concepts, definitions and constraints to allow the development of a viable integrated spacecraft and mission design concept. The resulting integrated concept will be the basis upon which detailed mission cost and schedule estimates can be generated. This effort will set the stage for final acceptance and confirmation of the instrument for the remaining development, implementation and operational phases (B, C, D and E) of the SDO Project and will culminate in a Phase A Concept Study Report (CSR) to be delivered to the SDO Project. The Contractor shall apply the necessary personnel, expertise, materials, services, equipment, facilities, institutional systems and software, and management processes to accomplish this work.

Specific objectives of this phase are to:

- a. Refine, consolidate and solidify the definition and conceptual design of the mission;
- b. Clarify and refine (as necessary) the investigation science requirements and plans;
- c. Refine and document required programmatic and engineering management processes for planning, monitoring, reporting and control;
- d. Identify and reconcile the driving instrument requirements and constraints within the governing set of mission requirements, constraints and objectives
- e. Clarify and integrate the instrument accommodation requirements and constraints, including the initiation of a detailed instrument Interface Requirements Document and companion Interface Control Documents;
- f. Review and assess the technology readiness and technical risk inherent in the instrument development and develop appropriate risk mitigation and descope plans; and
- g. Revisit and refine the preliminary cost and schedule estimates provided in the original instrument proposal submitted in response to the NASA Announcement of Opportunity AO 02-OSS-01 and generate updated estimates for the complete mission

Periodic technical interchange meetings at either the Contractor's facility or at GSFC will be required to effectively coordinate the Contractor and SDO Project efforts. The dialogue in these meetings will be structured to promote effective technical and programmatic interchange. The meetings shall pursue a valid accounting and assimilation of requirements and a complete and thorough assessment of technical and programmatic risk. Additionally, these meetings will facilitate mutual understanding of management plans and processes and technical plans and processes, and will clarify and promote the timely exchange of technical and programmatic documentation and information.

3. Task Statements

The Contractor shall perform the following tasks. Results of the associated work will be documented in the Phase A Concept Study Report (CSR). Specific instructions for the structure and content of the Concept Study Report are provided in Appendix A.

3.1 Management of the Investigation

This section encompasses the management effort required to effectively manage the administrative, business, science, engineering and operations elements of this project. The Contractor shall perform the work necessary to gather, assimilate and organize the disparate elements of the effort. The Contractor shall expand the management information provided in their response to NASA Announcement of Opportunity AO 02-OSS-01 and shall revise and update the management approach that will be used for the remaining phases of this investigation.

In mapping out the plans and commitments for Phases B, C, D and E, the Contractor shall focus on the following aspects:

- (1) Organization, roles and responsibilities including teaming arrangements and commitments,
- (2) In-situ and unique management practices, policies and methods employed to effect the required management disciplines,
- (3) Control processes including conflict resolution, decision making and delegation of authority,
- (4) Communications methods, practices and requirements including approach for external interfaces,
- (5) Management infrastructure and systems (currently existing or imminent) provided by parent organizations and utilized to enact management functions and controls, and
- (6) Identification and development of the companion management plans and procedures including configuration management; quality assurance; financial methodology for estimating, recording, analysis, reporting, and control; systems management and control; performance monitoring and measurement including progress metrics; schedule methodology; progress reporting; document control and distribution; and management review practices and policy.

The Contractor and its team may use their own management processes, procedures, and methods to the fullest extent practical, consistent with the requirements of this SOW and the contract. The use of innovative processes is encouraged when cost, schedule, technical improvements, and reliability can be demonstrated. Investigation teams shall define the management approach best suited for their particular teaming arrangement, including the E/PO program, which is commensurate with the complexities of the investigation's implementation approach and which provides an effective management structure necessary to assure the adequate control of development within the cost and schedule constraints.

3.1.1 Work Breakdown Structure

The Contractor shall prepare and use a Work Breakdown Structure to parse the project effort into manageable elements providing a clear structure for the generation and monitoring of costs and lower level schedules. The WBS and companion element descriptions shall be provided in the CSR.

3.1.2 Cost and Schedule Plans for Phases B, C, D and E

The contractor shall update the preliminary cost plan and associated master schedule for Phases B, C, D and E provided in the original proposal. The revised plans shall reflect the expansion and revamping of the proposal plans to reflect refined knowledge of the details of the requirements and associated work. The Contractor shall also develop and report detailed, networked schedules at the next level of detail which identifies the critical path and embedded reserve. The Contractor's development schedules must be consistent with the SDO Observatory development schedules. Significant changes in estimation premises shall be noted and described in the CSR. Appropriate cost and schedule contingency will be explicitly set aside and denoted. The contingency rationale shall be included in the CSR.

3.1.3 Sample Statements of Work for Phases B, C, D and E

The Contractor shall prepare and provide detailed Statements of Works for the Contractor's efforts in Phases B, C, D and E. The SOW will be based on the WBS generated in task 3.1.1. It shall include as a minimum: Scope of Work, Task Statements, Deliverables (including science products and data), and stipulated Government Responsibilities.

3.1.4 Documentation of Management Approach

The Contractor shall implement the organization, systems, policies and procedures necessary for the effective management and control of the project. The management approach outlined in the original proposal submitted in response to the NASA Announcement of Opportunity AO 02-OSS-01 shall be revisited and updated as necessary to reflect the specific interfaces to the SDO Project and the refinement of specific implementation details based on an ongoing programmatic dialogue with the SDO Project. The updated management approach shall be included in the CSR. In addition during Phase A, the Contractor shall identify and attempt to obtain the required foreign commitments from foreign partners. The status of the commitments shall be documented in the updated management approach in the CSR, including alternative backup plans if necessary.

3.1.5 Financial Administration

The Contractor shall establish the process for the effective fiscal management and administration of the project. The Contractor shall institute the necessary procedures and controls to effect a financial methodology for budget planning and revision, account authorization, accurate cost recording, up-to-date performance analysis, timely intercession, routine monitoring, status reporting and control. The methodology shall be

based on the WBS structure defined in task 3.1.1 and shall strive to minimize ambiguity between cost categories and accounts. The contractor shall identify and document the set of measuring metrics the Contractor employs to provide quantitative and unbiased indicators of the financial health and welfare of its program. The Contractor shall document its management approach for financial administration in the CSR.

3.1.6 Configuration Management Plan

The Contractor shall provide a draft Configuration Management Plan in the CSR. The plan shall describe in full the Contractor plan and approach for configuration management. In particular, the plan shall identify clearly the set of controlled documentation that will be subject to configuration management and shall clearly define the levels of change classification and the attendant action or process each invokes. For reference, the GSFC GPG 1410.2 for Configuration Management, dated January 24, 2000, is provided in Appendix C. The Contractor may use its own existing system if it is equivalent to the requirements of GPG 1410.2. Exceptions between the Contractor's configuration management system and the GPG guidelines will be explicitly documented in the CSR and must be approved by Goddard. Otherwise, the guidelines of the GPG shall prevail.

3.1.7 Performance Assurance Implementation Plan (PAIP)

The Contractor shall prepare and provide a Performance Assurance Implementation Plan (PAIP) written in response to the requirements of the SDO Mission Assurance Requirements (MAR) document. A copy of the current version of the MAR is provided in Appendix D. The MAR is in draft form and is still being generated and reworked. However, the MAR will be finalized and released during Phase A. The premise of the MAR is that the Contractor shall have an ISO 9000 or equivalent quality management system. If this is not the case, the Contractor may still use its own existing systems if the notable exceptions are approved by Goddard. Unless otherwise approved by Goddard, the requirements of the MAR shall prevail.

3.1.8 Risk Identification, Management and Mitigation

A key product of Phase A is the identification and accounting of all significant technical and programmatic risk inherent in the Contractor's programmatic plans and technical approach. These risks will be rolled up to the SDO Project level and will be routinely monitored for retirement or increase in threat. Specific risk mitigation plans shall be developed which define the actions and conditions necessary to offset or retire the risk. The Contractor shall also refine and update its descope plan which shall identify pre-defined prioritized actions to recover substantial cost or schedule savings through a prudent reduction or deletion of requirements, science objectives, technical content or other effort. The descope plans shall stipulate the specific descope actions, specify the schedule decision points for the effective execution of the descope and shall estimate the projected cost and schedule savings associated with the action.

The Contractor shall describe and document in the CSR its risk management process utilized to ensure successful achievement of the investigation's objectives within the

established resource, funding and schedule constraints. The methods for identification and capture of risk conditions shall be discussed along with the methods used to determine and instigate offset, mitigation or retirement actions. Critical system contingencies, error budgets and margins will be identified and the procedure and policy for the safe management of these reserves will be described. If the investigation has a significant no-cost foreign contribution, the Contractor shall define the specific coordination and control measures that will be employed to offset the programmatic risk inherent in the complexities of the teaming arrangement. The Contractor shall also identify all technology development items which require a dedicated development effort to bring these particular technologies or components to a Technology Readiness Level of 6 by the end of Phase B. The definitions of the Technology Readiness Levels are provided in Appendix E.

In the interest of offsetting potential schedule risk, the Contractor shall identify all long lead procurements which must be let during Phase A or early in Phase B to preserve the alignment of the Contractor's development schedule with the master schedule of the SDO Project which is based on the specified launch date. Prior to initiating these long lead procurements the Contractor shall obtain the approval of the Goddard before proceeding.

3.1.9 ITAR Considerations

The requirements and regulations of the US law enforcing the International Trade in Arms Regulation are a serious obligation of all US participants in the SDO program. The regulation is explicit and requires the existence of State Department approved authorization to engage in restricted technical dialogue and exchange of hardware and software. To this end, the Contractor shall initiate, as appropriate in Phase A, the necessary legal application for licensing with foreign partners as required under US law. Likewise the Contractor shall work with the SDO Project to generate the necessary draft international Letters of Agreement capturing the NASA agreements for cooperative work with the Contractor's affiliated foreign partners.

3.1.10 Unique Property, Services and Facilities

The Contractor shall determine and identify all unique capital property, facilities or other exceptional services which have to be constructed or procured for the execution of Phases B, C, D and E. The Contractor shall discuss the compelling motivation and need for such capabilities and shall provide associated cost and schedule estimates for discussion with the SDO Project. The Contractor shall not undertake undue obligations for these unique capabilities until the need has been reviewed and accepted by the Goddard. Those items which have the Goddard's approval will be documented in the CSR.

3.1.11 Technical Meetings and Reviews

Formal reviews to be held in subsequent phases of work in which both the Government and Contractor participate are defined in the SDO MAR. During Phase A, the Contractor shall prepare and conduct an Instrument Systems Requirements Review. This review shall address the completeness of the requirements determination and shall present the flow down of derived requirements. Requirements for all technical elements of the

project will be presented. The Contractor shall also prepare and deliver the associated presentation package for the review.

In addition, there will be numerous meetings routinely required by both parties to provide real-time and periodic forums for effective dialogue and coordination among their individual teams and between project teams. The Contractor shall enter into a dialogue with the SDO Project and identify the set of meetings involving participation by both parties. Furthermore, the Contractor shall define guidelines and conditions for Government participation in the Contractor's internal meetings and reviews. The Contractor will document these guidelines and conditions in the CSR as well as the frequency and location of the agreed upon set of standing meetings.

During Phase A, the SDO Project will hold a Kickoff Meeting and three other formal meetings in which the Contractor shall participate. The SDO Kickoff meeting has the principal objectives of introducing the technical teams, familiarizing the Contractor with the design and development efforts conducted to date for the SDO mission and spacecraft, and opening the programmatic dialogue. The Contractor shall participate and make presentation at the SDO internal Mission Definition Review and the mission Systems Requirements Review. These meetings are precursor meetings for the formal combined Systems Requirements Review/Systems Concept Review presented by the SDO Project to an independent panel of reviewers as part of the NASA Headquarters' formal confirmation review process. The Contractor shall participate in this meeting, and shall prepare materials for this meeting as appropriate. Goddard and the Contractor will consult on the required agendas for these meetings. A draft timeline for Phase A is provided in Appendix B for reference purposes only.

The Contractor shall provide the necessary resources to prepare technical and programmatic data packages for distribution and presentation at meetings and reviews in which the Contractor will make a presentation. For formal reviews and meetings advance draft copies of the presentation shall be submitted to the GSFC/SDO project for review prior to the presentation.

3.1.12 Monthly Progress and Final Report

Instrument developers shall submit monthly technical progress reports including the companion (533M) and quarterly (533Q) financial management reports as required by the contract. They shall be prepared to the WBS Level II, by elements of cost and associated WBS. All financial management reports shall contain explanations of variances from planned expenditures. The technical progress report shall also contain updated project schedules and staffing plans (including subcontractor staffing). If at all possible, electronic submission of the report is preferred with one signed hardcopy submitted through the mail for authentication and archival purposes.

The Contractor shall prepare and deliver a Final Report as the last technical progress report for this contract period. The Final Report shall document and summarize the results of the entire contract work during the contract period, including recommendations and conclusions based on the experience and results obtained. Relevant graphical documentation such as graphs, drawings, diagrams and photographs shall be included as

appropriate.

3.2 Systems Management

The Contractor shall perform the systems management and systems engineering functions necessary for the effective identification, integration and control of requirements and the effective identification, assessment and mitigation of technical risk. In addition, an essential function of the Contractor's systems management effort is to define, establish and promote the guiding systems policies and procedures for the Contractor's technical approach. The Contractor shall outline and describe in the CSR the means and methods by which systems management and systems engineering will be implemented and applied.

Specific systems management and systems engineering tasks are:

3.2.1 Consolidation of Systems Requirements and Identification of Design Drivers

The Contractor shall completely identify and consolidate all relevant engineering requirements (including derived requirements), and the Contractor shall institute systems management practices and procedures to effectively and properly control these requirements. The Contractor shall lay out and begin generating the traceability documentation to capture the flowdown and relationships of requirements. The Contractor shall ensure these requirements are consistent and compatible with the overarching mission requirements. The key design drivers shall be identified and discussed. It is vitally important to clearly understand the compelling need and associated constraints imposed by these design drivers in order to assure an effective accommodation of the requirement. The Contractor shall generate the necessary systems requirements documentation to document the engineering requirements. Configuration management of these requirements shall be consistent with the Contractor's configuration management practices. A draft version of the requirements including initial traceability documentation will be provided with the CSR.

3.2.2 Systems Model and Error Budgets

The Contractor shall define its plans for generation and use of a mathematical systems model and companion error analyses. These will become valuable trade study tools during Phases B, C, D and E. The Contractor shall describe its approach for modeling and budgeting of system performance margins and errors in the CSR.

3.2.3 System Test, Sparing and Redundancy Philosophies

The Contractor shall present and describe in the CSR the governing guidelines for testing, sparing, redundancy and fault tolerance. Since there are no standard practices or guidelines for the approach taken in these areas, there is potential for significant risk if judicious choices are not made. Because these areas can be approached and implemented in so many different ways, the Contractor shall outline its planned approach for each of these elements in the CSR to facilitate an early assessment of risk.

3.2.4 Systems Management Involvement in Risk Management

In concert with the program management risk management requirements of task 3.1.8, the Contractor shall also perform the systems management functions necessary for the determination and assessment of technical risk within the Contractor's program. The Contractor shall implement a systems management process that formally tracks the technical risk inherent in the technical development of the instrument and supporting systems. This process shall focus primarily on design, technology readiness, manufacturing, assembly, integration, test and operational risks. The Contractor's process will ensure timely identification and reporting of risk and shall marshal the necessary resources to develop and implement an appropriate risk mitigation or risk offset action plan. In the CSR, the Contractor shall clearly describe the role and responsibilities of systems management and systems engineering in the risk management program. The Contractor shall also provide in the CSR an updated breakdown of the relevant flight heritage that is claimed to apply to the instrument and its various components. The relevance of the heritage will be noted, particularly if the design conditions from original application are not completely identical to the current application.

3.2.5 Trade Analysis

The Contractor shall employ systems engineering methods and tools to refine and trade performance characteristics of the instrument design as required to optimize science measurement capabilities and to assure efficient use of SDO physical resources (mass, volume, power, thermal view, data rate, etc.). The Contractor shall work in concert with the SDO Project to focus on and participate in the mission engineering trades that will produce a viable accommodation of the instrument and a workable sharing of the limited resources of the spacecraft with the other SDO instruments. The Contractor shall report in the CSR all ongoing trade analyses that have been undertaken as well as any known issues which will require trade analyses to be performed. Significant changes in the capabilities of the "as proposed" instrument resulting from completed trade analyses shall also be noted in the CSR.

3.2.6 Initial Fault Analysis

One of the toughest questions that needs to be addressed in the early stages of the development process is the determination of how much redundancy is required to affordably offset mission lifetime risks. This concern applies to both the Observatory and the instrument. To facilitate this assessment, the Contractor shall prepare an initial simplified fault analysis which identifies mission critical single point failures. This information will be used to focus attention on the criticality of the potential fault and on the potential mission options to offset these risks. A brief synopsis report summarizing the results of the analysis will be provided in the CSR.

3.2.7 System and Peer Reviews

The Contractor shall implement a routine systems review process to ensure ongoing insight by systems managers and systems engineers into the evolving design of the

investigation and instrument. As necessary, the Contractor shall institute a less formal peer review process which shall serve as a objective systems review forum at lower levels. The purpose of the peer review is to provide a timely and independent critique of the technical soundness of the design approach being pursued and to ensure relevant lessons learned and corporate knowledge are brought to bear to ward off unnecessary mistakes or complications, thus minimizing undue technical risk or loss of schedule or waste of budget. The Contractor shall outline and document in the CSR the systems review process and methodology baselined for the project.

3.3 Science Investigation

The Contractor shall participate in the SDO Science Working Group forum and shall refine and update the science investigation plans and concepts. The Contractor shall note in the CSR all significant modifications and enhancements to the investigation objectives, plans and concepts as originally provided in the original proposal.

3.3.1 Science Working Group

The purpose of the SDO Science Working Group is to provide a working forum for the SDO scientists with the common goal of maximizing the scientific return of the mission within the existing resources. The Contractor shall open a dialogue with the SDO Project Scientist to define and develop the working charter of this group. The Contractor shall participate in at least one Science Working Group meeting in Phase A.

3.3.2 Science Requirements

The Contractor shall generate the Level 1 science requirements for the investigation consistent with the SDO Project science objectives. In addition, the Contractor shall identify a minimal subset of the Level 1 requirements which will represent a minimally successful investigation. The minimal subset provides a reference point for potential descope options that may be invoked to offset risk or restore programmatic reserves.

Since the science requirements will become driving requirements for the design of the instrument and the constituent mission and science operations centers, the Contractor shall also develop and document the Level 2 science requirements. A draft version of the science requirements document shall be included in the CSR.

3.3.4 Science Operations

During Phase A, the Contractor shall refine the operations concepts for the conduct of flight operations and the concepts for the acquisition and routing of the raw science data stream including any temporary buffering of this data to affordably minimize risk of loss once on the ground. The Contractor shall also refine its implementation plans for the conversion of the raw data into valid research quality data and data products. The Contractor shall describe in the CSR its implementation approach for the acquisition, validation, data processing and eventual data distribution and archiving of the investigation's science data including public access concepts. The Contractor shall revise and clarify the resource estimates for the hardware and software required to conduct the

science operations. The Contractor's associated cost plans shall be revised accordingly. Goddard will provide the mission operations resource estimates.

3.4 Instrument Hardware Design and Engineering

The engineering efforts of Phase A will focus on the fleshing out of the initial instrument and investigation concepts and on the efforts to map out the viable trade space required to effectively integrate multiple instruments onto the SDO spacecraft and into the SDO mission science. These efforts are important for the reasonable evolution of the mission design within the defined cost, schedule and physical (launch vehicle and spacecraft) constraints of the SDO program. To this end, the Contractor shall expend the following specific engineering effort to update and refine the design and technical approach for the development of the instrument. The results of these efforts shall be documented in the CSR.

3.4.1 Accommodation Engineering

The Contractor shall conduct the necessary engineering design and analysis effort to determine a workable physical accommodation of the instrument onto the SDO spacecraft. The accommodation effort will not be finalized until well into later phases of design development, however, the design effort shall begin in earnest in Phase A and shall define an initial accommodation of the instrument. In order to facilitate this effort the Contractor shall produce simplified 3D CAD (computer aided design) layouts of the instrument which readily define overall physical layout and envelope, mechanical mounting, unobstructed thermal and optical field of view zones and orientation constraints. The CAD model shall be delivered to the SDO Project for use in its iterative accommodations design process. Also, if at all possible, the Contractor shall develop and deliver a simplified thermal model for similar use.

The SDO Project has developed an initial concept for the SDO spacecraft and has isolated the key design drivers and accommodations challenges. Some of the specific accommodations issues that shall be addressed during Phase A are:

- a. Mechanical: Mounting approach and kinematic isolation, orientation and location on spacecraft, use of CAD models, alignment and alignment stability requirements, first mode estimates and finite element modeling requirements
- b. Thermal: Location of radiator surfaces and clear thermal field of view requirements, use and accommodation of embedded heat pipe systems, thermal isolation at the mounting interface, operational and survival thermal environment requirements, special test requirements (particularly spacecraft thermal vacuum), requirements and use of thermal models
- c. Optical/Focal Planes: Unobstructed optical fields of view, special access or test requirements (such as use of external space simulator, test fixtures, or other specialized GSE)
- d. Attitude Control System and Guidance and Navigation: Pointing stability and jitter

requirements, definition and characterization of required on-orbit calibration maneuvers, Guide Telescope co-alignment and performance requirements, and clarification of spacecraft safe modes

e. Science Data Quality: Clarification of science data completeness, data continuity, data latency and acceptable data loss requirements

f. Electrical Interfaces: Clarification of command and telemetry interface requirements, clarification of high rate science data interface and temporal characteristics, review and accommodation of embedded microprocessor and affiliated resources, grounding and harness constraints, clarification of operational modes and health and welfare monitoring

g. Contamination: Clarification of spacecraft cleanliness, work space cleanliness, purging and contamination monitoring requirements including on-orbit outgassing and exposure constraints

h. Radiation Considerations: Clarification of approach to and requirements for the selection of parts or incorporation of electrical design features to address radiation issues of total dose, charging, deep dielectric discharge and single event effects

This list of accommodation considerations is not all-inclusive and will expand in the course of the working dialogue between the Contractor and SDO Project engineering teams. The Contractor should immediately note and report to the SDO Project implied accommodation work which is outside the planned scope of effort.

3.4.2 Mass and Power Budget Updates

The Contractor shall update the initial mass and power estimates provided in the original proposal. It is understood that this will be an ongoing process that will achieve higher fidelity with time. For Phase A the Contractor shall provide the rationale in the CSR for the margins set aside for these budgets and shall define the targeted reserve levels to be held for each of the remaining phases (B, C, D and E). The required reserves should diminish with each phase as a result of the greater design and product maturity achieved in each phase.

3.4.3 Pointing Jitter Estimates and Requirements including Guide Telescope

The Contractor shall determine the performance requirements and characteristics for the installation, operation and use of Guide Telescope(s).

3.4.4 Preliminary Instrument Specification

The Contractor shall generate a draft Instrument Functional Requirements and Performance Specification. The document shall be incorporated into the CSR. The document will be baselined prior to the Preliminary Design Review in Phase B.

3.4.5 Preliminary Instrument Interface Requirements and Control Documents

The Contractor shall develop and generate the Contractor's inputs to the preliminary Instrument Interface Requirements Document (IIRD). The IIRD will be maintained and controlled by the SDO Project. The IIRD shall capture all interface requirements for both sides of the interface and shall define the necessary products and analysis required from the Contractor to support the integrated mission analyses to be performed by the SDO Project as the mission integrator. Typical mission analyses are integrated loads analysis, integrated thermal analyses, orbital debris analysis, etc.

The Contractor shall provide inputs and technical documentation to the preliminary Interface Control Documents which capture the implementation details of all physical interfaces with the spacecraft.

3.4.6 Ground Support Equipment and GFE (Government Furnished Equipment)

The Contractor shall update the list of expected ground support equipment planned for use in the program. The Contractor shall include the list of expected equipments furnished by the Government for use in the program. Typical GFE includes drill and alignment fixtures, mounting hardware (flight and non-flight), spacecraft electrical interface simulators, etc. The combined list shall be included in the CSR.

3.4.7 Instrument Manufacturing, Integration, Test and Calibration

The Contractor shall refine and update its approach to the manufacturing, integration, test and calibration of the instrument. The Contractor shall document the resulting alterations and improvements in the CSR. Of particular interest are unique or unusual requirements or constraints that require a significant commitment of resources or time. The Contractor should identify any critical performance characterizations or unique tests (or calibrations) that cannot be repeated after delivery to the spacecraft.

3.4.8 Observatory Integration and Test

The Contractor shall develop and update the plans for the Contractor's support and involvement in the Observatory integration and test efforts. The goal is to develop a workable approach to the integration and test of the instrument on the spacecraft. Key areas of interest are handling and access, need and use of specialized ground support equipments, need and use of calibration targets, needs and use of short form or abbreviated functional tests, requirements for periodic baseline functional and performance checks, needs and use of common STOL (System Test and Operations Language), and effective management and control of contamination risks. The Contractor shall describe the updated approach in the CSR.

3.4.9 Technology Demonstration Hardware

The Contractor shall define the specific requirements and plans for the manufacture and test of technology demonstration hardware. This includes bread boards and brassboards, engineering model or engineering test hardware, proto-type or proto-flight hardware, life test units and appropriate Technology Readiness demonstration hardware required to achieve a Technology Readiness Level of 6 by the end of Phase B (see paragraph 4.1.8).

A summary of the plans and approach for demonstration hardware will be included in the CSR.

3.4.10 Directed Reliability Enhancements

To improve overall reliability for mission success, the contractor shall incorporate the following reliability enhancements to the HMI instrument:

1. Adding central processor redundancy based on a dual string approach including all associated signal, power and control circuitry required for this implementation; and
2. Adding redundancy to the filter and polarization mechanisms to preclude a single point failures caused by stuck mechanisms.

The contractor shall document these improvements in the CSR and shall provide a separate line item for the associated costs of these improvement in the detailed cost estimate required in Paragraph 3.1.2.

3.5 Software Development

The Contractor shall begin the software development effort and shall initially focus on finalizing the software development approach and refining the conceptual software architecture. The Contractor shall also implement an effective software management and engineering process to produce reliable low maintenance flight and ground software. The Contractor shall define and document in the CSR the software development approach including provisions for software change control and independent verification and validation. The Contractor shall extract the initial set of software functional requirements and shall prepare a draft Software Functional Requirements Document for inclusion in the CSR.

3.6 Mission Operations

The Contractor shall clarify and refine the SDO mission operations concept and ground system architecture. Specific aspects that shall be addressed include layout and interconnect of the mission operations components and operational facilities, apportionment of the mission operations engineering tasks between the Contractor and Goddard, manning strategy, data buffering and archival strategies, observation planning and science data distribution. The Contractor shall clarify and refine baseline observation scenarios including routine (hands-off) operations, initial commissioning and approach to on-orbit checkout, and any unique maintenance, target of opportunity and on-orbit calibration operations.

3.7 Education and Public Outreach (E/PO) Program

The Contractor shall refine and document the Contractor's approach and plans (including content) for an Education and Public Outreach program. The Contractor shall work with the SDO Project Scientist to review and clarify the E/PO program.

List of Appendices

Appendix A – Instructions for the Phase A Concept Study Report

Appendix B – Reference Phase Schedule

Appendix C – GSFC Configuration Management GPG

Appendix D – GSFC MAR

Appendix E – Technology Readiness Level Definitions